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Countering China's Dominance in the Rare Earth Element Market System

by

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COUNTERING CHINA'S DOMINANCE IN THE RARE EARTH ELEMENT MARKET SYSTEM

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ABSTRACT

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COUNTERING CHINA'S DOMINANCE IN THE RARE EARTH ELEMENT MARKET SYSTEM

The United States has lost the ability to produce and control the rare earth elements (REE) required to sustain a strong national defense and a robust economy. Without a strong economy, the U.S. is challenged to pursue the goals and objectives outlined in the 2010 National Security Strategy.[1] From the 1960's through the 1980's, the United States was the world's leading producer of REE[2]. As of 2009, China produced 97% of the world's supply of REE while controlling only 36.5% of the world's reserves.[3] China's monopoly of the world's supply and production of REE provides both an economic advantage but also a weapon to wield for achieving political ends. The short-term cost benefits of U.S. industry pursuing an inexpensive source of supply coupled with a lack of U.S. government oversight of emerging strategic materials has resulted in movement of REE production outside the sphere of influence of the United States.

The world's high-technology driven modern society is becoming increasingly dependent on REE. REE are critical in the manufacture of modern information and weapon systems as well as clean and renewable energy initiatives.[4] The globalized economy prevents the U.S. from finding wholly internal solutions to REE requirements. The U.S. must work with its global trading partners to satisfy U.S. REE manufacturing, trade and consumption requirements for while also maintaining the requirements of trading partners.

Worldwide REE requirements are increasing annually as the global appetite for high-technology information and defense systems increase. World REE demand in 2009 was estimated at 134,000 tons with an estimated requirement of 180,000 tons for

2012, increasing to 200,000 tons in 2014. Unfortunately, China's projected mining and refining capacity for 2014 is only estimated to be 160,000 tons -- a 40,000 ton deficit.[5]

Although these REE projections may sound bleak, the U.S. government and its trading partners have begun to recognize the uncertain REE situation. The U.S. Geological Survey (USGS) predicts that 11.4% of the world's viable concentrations of rare earths are located within the United States.[6] USGS and European Union (EU) studies discuss worldwide concentrations of rare earth elements and surveys for new deposits continue. Corporations and non-government agencies are also studying the options available to reestablish other sources of rare earth elements along with development of substitutions.

This paper will discuss the importance of REE in achieving the goals of the National Security Strategy and offer a set of economic solutions to regain a degree of control over the supply and demand of REE vital to our national defense.

A Brief Introduction to Rare Earth Elements

REE comprise 17 elements found on the periodic table. The first 15 are classified as the lanthanide series in the periodic table of elements and form the largest chemically coherent group in the periodic table.[7] In addition to the 15 lanthanides, yttrium and scandium are also classified as REE. Yttrium's consideration is based on the chemical and physical similarities it shares with the lanthanides [8] and scandium because of its abundance in most REE deposits[9]. The term "Rare Earths" is a misnomer; REE are actually quite abundant in the Earth's crust but were designated as rare when they were first discovered as oxide components within seemingly rare minerals.[10]

The deposits of REEs are generally classified as either Light Rare Earth Elements (LREE) or Heavy Rare Earth Elements (HREE) as many of the elements are

found together within mined deposits. (See Table 1.) Although the deposits are classified as either LREE or HREE, minerals of both types can be found within one deposit. Minerals and deposits with LREE are more abundant than those with HREE.[11]

Light Rare Earth Elements	**Heavy Rare Earth Elements**	**Non-Lanthanides**
Lanthanum	Europium	Scandium
Cerium	Gadolinium	Yttrium
Praseodymium	Terbium	
Neodymium	Dysprosium	
Promethium	Holmium	
Samarium	Erbium	
	Thulium	
	Ytterbium	
	Lutetium	

Table 1. REE Classifications[12]

The process of REE mining, refining, and production is expensive and complex. Rare earths must be mined, separated, refined, and alloyed prior to manufacturing into components or end items.[13] Additionally, the environmental impact of the mining and refinement process adds additional expense and complications to the overall process.[14] The United States' last operating mine at Mountain Pass, California was shut down in 2002 because of wastewater disposal problems[15]. Molycorp, the company that owns the Mountain Pass facility, is currently in the process of restarting operations and expects to restart production in 2012 with an expansion in 2014.[16] The USGS estimates that the Mountain Pass deposit contains sufficient LREE resources to meet domestic demand; however, the deposit does not contain sufficient HREE to meet current demand.[17]

Although 97% of REE production occurs in China, REE deposits are found worldwide. Of the current known REE reserves, China holds 48.3%. Other known world

reserves are as follows: Russia and the Commonwealth of Independent States 16.7%, United States 11.4%, Australia 1.4%, India 2.7%, and other countries 19.4%.[18] These percentages are based on the current known world reserves in 2011, approximately 113,778,000 metric tons.[19] However, considering that in 2009, the US Geological Survey estimated the known world reserve at 98,578,000 metric tons[20], additional unknown reserves may be discovered as countries and corporations explore more deposits.

<u>REE Uses</u>

As our defense systems become increasingly sophisticated and complex, REE access will become progressively critical. Defense applications requiring REE include: precision guided munitions, aircraft, ground combat systems, communications systems, information management systems, rangefinder and guidance system lasers, satellite systems (ground and orbital), night vision goggles, and optical lenses. As this abbreviated list shows, U.S. national defense is directly linked to the U.S. ability to access REE. The Department of Defense's (DoD) reliance on REE for replacement of components and manufacturing of precision guided ammunition is a vulnerability that impacts sustainment of combat forces during a conflict and the reset of equipment and the reconstitution of units following redeployment. This problem is further compounded by the DoD's heavy reliance of Commercial-Off-the-Shelf (COTS) systems for operational purposes and institutional requirements. The supply chain for COTS equipment and components is difficult for the DoD to manage because of the multiple levels of subcontractors and sources of materials and components.[21]

The expanded use of clean and renewable energy technologies is key to transforming the U.S energy economy. Clean and renewable energy initiatives reduce

the need to mine and drill for domestic mineral energy and reduce the reliance on foreign resources of oil. Current reliance on fossil fuels leaves the U.S. vulnerable to energy supply disruptions and manipulation and to changes in the environment on an unprecedented scale.[22] The clean and renewable energy initiatives included in the NSS are reliant on access to REE. REE are essential to the production of wind turbines, low energy lighting, and batteries used in electric and hybrid vehicles.[23] Table 2, below, shows the individual uses of selected REE for clean and renewable energy technology development. The cost and availability of REE affects the rate of development for renewable energy sources in the U.S., keeping the U.S. dependent on foreign sources of energy.

Defense and clean energy applications aside, consumer and industrial applications for REE are continually increasing. REEs are commonly used as ingredients in catalysts, such as the fluid bed cracking catalysts used to improve the efficiency of the crude oil refining process and other industrial applications. Another common use of REE is as additives in the treatment of wastewater, pool and spa water, and industrial processes to remove arsenic and heavy metals. REE is present in the magnets and coatings used in many high-technology information systems. Cell phones, personal digital assistant devices, digital music players, hard disk drives used in computers, computing devices, speakers and microphones, and fiber optics depend on the U.S. and its trading partners' access to REE.[24] These REE-dependent communication and information systems are critical to the infrastructure of the U.S. and are integral to the U.S. economy.

	Clean and Renewable Energy Technologies and Components			
	Wind Turbines	**Vehicles**		**Lighting**
Element	**Magnets**	**Magnets**	**Batteries**	**Phosphors**
Lanthanum			X	X
Cerium			X	X
Praseodymium	X	X	X	
Neodymium		X	X	
Samarium	X	X		
Europium				X
Terbium				X
Dysprosium	X	X		
Yttrium				X

Table 2. REE applications in Clean and Renewable Energy Applications[25]

A 2004 Rand report concluded that computer and electronics manufacturing is a major U.S. industry, ranking third in employment, third in manufacturing value added, and fourth in shipment value. Of the 15.9 million U.S. manufacturing employees, only the fabricated metals and transportation industries employ more people than the computer and electronics industries.[26] Additionally, Information-communications-technology-producing industries accounted for 24 percent of real GDP growth in 2010[27] resulting in information-communications-technology producing industries contributing 4.7% to the U.S. GDP.[28] Many other industries use these high technology products to drive and manage their own industrial processes. Table 3 shows the wide use of REE in today's high technology-driven economy.

Element	Example Applications
Scandium	Metal Alloys for the Aerospace Industry
Yttrium	Phosphors, Ceramics, Metal Alloys
Lanthanum	Batteries, Catalysts for Petroleum Refining
Cerium	Catalysts, Polishing, Metal Alloys
Praseodymium	Magnet Corrosion Resistance, Pigment
Neodymium	High Power Magnets for Laptops, Lasers
Promethium	Beta Radiation Source
Samarium	High Temperature Magnets, Reactor Control Rods
Europium	Liquid Crystal Displays, Fluorescent Lighting
Gadolinium	Magnetic Resonance Imaging Contrast Agent
Terbium	Phosphors for Lighting And Display
Dysprosium	High Power Magnets, Lasers
Holmium	The Highest Power Magnets Known
Erbium	Lasers, Glass Colorant
Thulium	Ceramic Magnetic Materials
Ytterbium	Fiber Optics, Solar Panels
Lutetium	X-Ray Phosphors

Table 3. REE Applications in Today's Economy[29]

The Risk

China's monopoly on the World's REE supply and production allows the Chinese government to directly control REE flow to U.S. commercial and defense industries. Even with Molycorp restarting production and planning for future expansion, if China restricts REE in either a processed form or as components, the reduced U.S supply could raise commodity prices, affecting not only the price of critical defense needed REE but also the price of REE required for consumer and energy needs. Peter Leitner, a former senior strategic trade adviser at the DoD, stated "The Pentagon has been incredibly negligent. There are plenty of early warning signs that China will use its leverage over these materials as a weapon."[30] The DoD is aware of the shortcomings of

the REE supply chain and conducted several REE studies to include one study examining 24 weapon systems and another examining the national security implications of China's dominance on World supply.[31]

China's REE supply dominance can damage the U.S. economy, delay the conversion to clean and renewable energy systems, and has the potential to influence U.S. national policies regarding China and other nations. The most obvious way to affect the U.S. economy is out right denial of REE to the United States. Restricting access would result in suspension of U.S REE-dependent production or force acquisition of REE required through a third party country, at higher prices because of the additional link within the supply chain. For example, in September 2010 China restricted exports of REE to Japan because of a dispute over the detention of a Chinese fishing boat captain whose boat collided with a Japanese Coast Guard cutter off the Senkaku Islands in the East China Sea. China restricted REE to Japan as a diplomatic tool to expedite the release of the fishing boat captain.[32] Although China denied the allegations of restricting REE shipments to Japan, Japan and other nations remain concerned that China is clearly willing to use REE as an economic tool to exert pressure on political issues.[33] Since many of the products used in the U.S. come from Japan, the restriction also affected the U.S. by delaying shipments of Japanese goods to the U.S.

Similar to withholding REE to U.S. industries, China could prioritize REE exports to another nation. By prioritizing supply, China can make a diplomatic statement on U.S. policy without the blatant and messy diplomatic results of an embargo. China has already prioritized REE production away from exports to Japan in order to provide additional development of manufacturing processes within China.[34] As China's

industrialization grows, it is developing a high tech manufacturing capability in fields that Japan has dominated for the last few decades. Instead of shipping REE to Japan for production of components and products, China is retaining more profits by shifting manufacturing away from Japan and into China.[35] This action by China and by Japanese and American companies investing in China's REE production infrastructure vice U.S. production capabilities further empowers China's economic dominance.

A rise in REE commodity prices or tariffs can negatively affect the U.S. economy and defense industries. Manipulating prices of REE is a method to control the supply and demand in order to increase profits, affect policy or to manipulate the supply chain. China has been imposing tariffs and quotas on its rare earth exports for several years, curtailing global supplies and forcing prices to rise eightfold to fortyfold during that period for the various REE.[36] Inversely, as long as China maintains REE supply dominance it can also reduce prices if required to discourage the development of REE production outside of China. China has been attempting to invest in overseas REE mining operations allowing her to control the production and prices outside of China. In 2009, Australia blocked a Chinese bid to purchase a controlling stake in an Australian REE mine[37]. Australia blocked the attempt to ensure that Australia would remain a reliable supplier to all of her trading partners and national interests.[38]China's dominance not only affects U.S. REE access through deliberate Chinese actions but also from non-deliberate regional events. Internal Chinese political and social events may also affect the supply of REE from China. In the past few years, the People's Republic of China has experienced rising social unrest, including protests, demonstrations, picketing, and group petitioning.[39] Large-scale rioting or labor strikes can cause delays in production

and shipment of manufactured goods or raw REE to western markets. Although unlikely, a revolution may cause even economic crippling shortages in REE for months as very little production yet occurs outside of China.

Outside of revolution, environmental disaster may cripple the World's source of REE. The 2011 Japan earthquake and resulting tsunami is an example of what could happen to China, as it also sits on the edge of the Pacific Rim. A recent webinar conducted by AM Best reported, "Should a calamity the magnitude of the earthquake and tsunami in Japan or the flooding affecting Thailand occur on the East Coast of China, 60% of that country's economy is at risk, exposed as those production centres are to windstorm, earthquake and flood damage.[40]" The discussion further outlined that China's industrial east coast is at risk because of most of it is located at or below sea level and it is vulnerable to flooding and tsunami. The insurance industry is also concerned about the sophistication of China's risk and emergency management systems.[41]

Chinese regulation and prioritization of REE for the Chinese industrial base over export is a logical business practice to promote domestic growth and economic well-being. China consumes more than 60% of its current REE production and is expected to further increase its domestic consumption as it increases profits by expanding its manufacturing base and increases investments into its own domestic industries requiring REE.[42] The Chinese government is imposing restrictions on export quotas on REE in an effort to protect its REE resources and ensures its own needs are met. China is also attempting to improve management and control of its REE resources by closing down smaller and illegal rare earth operations, consolidating larger operations, and

allocating increased REE production to stockpiles. [43] China's Ministry of Commerce has concerns that at current growth rates in REE demand, China's HREE supply could be depleted in the next 15-20 years.[44] China's concerns over supply have increased domestic exploration and additional investment in foreign REE mining operations.

Solutions

Although the US government and business sector was shortsighted in allowing REE production to move to China, Congress and the private sector are responding to US loss of control of its REE supply chain. U.S. Government and industry have eventually recognized the shortsightedness of over reliance on cheap sources of REE and the loss of secure domestic REE sources. Once the Mountain Pass REE facility was closed down in 2002, the U.S. lost not only a critical production capability but also the ability to quickly restart REE production. Additionally, the U.S. lost its technical edge to China as the center for REE technical knowledge and research has moved from the U.S. to China.[45] Governments and businesses in other nations are also concerned and have been working to develop production capability or to secure sources through trading partners.[46]

The United States Government end state for REE should be to establish long-term access to reliable sources in order to maintain a strong economy, achieve clean and renewable energy infrastructure development, and maintain a ready, modernized defense sector. In a globalized economy, this goal must also include access to external REE supplies and the provision of U.S. REE supplies to our allies and trading partners. Achieving this goal does not mean that the U.S. should seek to remove all requirements for China's REE; rather, the U.S. must diversify its REE sources and transform the U.S. from a REE importer to a REE net exporting country. The U.S. Department of Energy

(DoE) critical materials strategy describes a path to achieving long-term U.S. access to REE.

> DOE's strategy with respect to critical materials rests on three pillars. First, diversified global supply chains are essential. To manage supply risk, multiple sources of materials are required. This means taking steps to facilitate extraction, processing and manufacturing here in the United States, as well as encouraging other nations to expedite alternative supplies. In all cases, extraction and processing should be done in an environmentally sound manner. Second, substitutes must be developed. Research leading to material and technology substitutes will improve flexibility and help meet the material needs of the clean energy economy. Third, recycling, reuse and more efficient use could significantly lower world demand for newly extracted materials. Research into recycling processes coupled with well-designed policies will help make recycling economically viable over time.[47]

To achieve the goal of long-term access, the United States Government and the commercial sector must understand that investment is required to re-establish mining and production capability, find and develop substitutes, educate the American workforce, and develop the means to mine and process REE in an environmentally neutral manner. With the current economic crisis, investment in production capability and infrastructure will be challenging. However, investment in REE development will not only create jobs in the short run, but in the end, the U.S. will become more secure and economically sound. With 11.4% of the known world's viable concentrations of rare earths located within the United States, Australia's known reserves of REE [48], and Canada's developing HREE sources within the Northwest Territories[49], the U.S. can partner with stable trading partners and defense allies to create secure access to vital REE sources. As other foreign sources are discovered and developed, the United States Government (USG) should encourage investment into these sources to expand the breadth of sources and add U.S. influence to the operations and distribution of product.

Environmentally friendly REE mining and production processes are another sector that would benefit from USG investment. As the U.S. must re-establish its mining and processing infrastructure, the USG should create incentives for industry to encourage environmentally friendly processes and practices into new facilities. Investment in environmentally friendly infrastructure early will save capital in the long run by avoiding the need to add or refit facilities with clean systems in the future. Additionally, the introduction of clean processes now will help to avoid the costs of environmental cleanup and possible ecological disasters and incidents requiring shut downs and disruptions in production later. China neglected environmental concerns and is currently dealing with the environmental issues now while trying to control production. The effect to the environment, public health, and the degradation of farmland is imposing costs on China that are not compensated by the sales of Chinese REE.[50]

Recycling and reuse technologies provide another investment opportunity . Urban mining can assist in reclamation of many of the REE that have already been imported to the U.S. within now-obsolete cell phones, televisions, and computers. Japan has already begun investing in urban REE mining. Japan's Kosaka Smelting and Refining Company built a recycling plant whose furnace melts old electronics parts into a molten stew from which valuable metals and other minerals are extracted. The electronic parts are collected from Japan and overseas, including the United States. Kosaka has successfully reclaimed rare metals like indium, used in liquid-crystal display screens, and antimony, used in silicon wafers for semiconductors and is developing reclamation techniques to extract REE such as neodymium, a vital element in industrial batteries used in electric motors, and dysprosium, used in laser materials. The

Japanese National Institute for Material Science calculates that used electronics in Japan holds an estimated 300,000 tons of REE.[51]

One problem with recycling is that it is currently expensive to perform. However, as recycling evolves the costs should also drop. Selective recycling may be a short-term solution. One example is with neodymium-iron-boron (NdFeB) magnets, the most common REE magnet. NdFeB Magnets are permanent magnets made from an alloy of neodymium, iron, and boron and have a high potential to be recycled, remanufactured, and reused because the magnets can be selectively disengaged from the assemblies in which they are used. Although, NdFeB magnets often corrode with use, thus increasing recovery costs, Hitachi has developed a process to recycle REE magnets from hard disk drives and has then successfully extracted these REE magnets.[52]

From a technical perspective, permanent magnet recycling may be a promising candidate for recycling investment. In the event that REE supply cannot keep up with demand, the price of REE would rise making recycling and reuse more cost effective.[53] However, unless prompted by a rise in commodity prices, private industry is unlikely to invest the capital to develop the technologies in order to avoid a rise in prices; government investment to speed the development of recycling may be a prudent course of action.

Cindy Hurst of the U.S. Army's Foreign Military Studies Office pointed out another investment opportunity for the US:

> The U.S. would also benefit if it could figure out how to extract the rare earth from tailings materials. Under the current technology, significant amounts of rare earth elements are left behind in these tailings materials. Some are simply not recoverable in the floatation process. Until we figure out how to maximize extraction efforts, much of the rare earth elements simply go to waste.[54]

This investment in extracting REE from tailings may create revenue by selling the technology to other countries that have iron deposit mine tailings that may contain REE. Many of the REE deposits in China actually come from what were originally iron mines, so there is a large supply of tailings that may contain REE.

The investment in REE sources can come from low interest rate loans and tax incentives for companies that invest and develop REE mining and processes. REE that sits on USG land can be mined by allowing bids for private mining companies to mine the REE in a government owned/contractor operated facility. This would reduce the entry costs to the contractor while allowing the government to control the resource. Congress could legislate tax incentives to companies that invest in both domestic and foreign REE operations. Foreign investment could be directed to trading partner countries and to developing countries that are believed to remain friendly to the U.S. Many private companies are hesitant to make investments with a long return on investment horizon, but the government can direct investment into these long time horizon opportunities through tax incentives and loan guarantee programs.

The investment in intellectual capital is well suited for the government over private industry. The government can invest money into research and education to develop clean and efficient mining, production, and reclamation processes. President Obama touched this point in his 2011 State of the Union address when he said, "Our free enterprise system is what drives innovation. But because it's not always profitable for companies to invest in basic research, throughout our history, our government has provided cutting-edge scientists and inventors with the support that they need."[55]

Developing trade partnerships between other reliable trading partners and allies will facilitate long-term access to REE sources for the United States. These partnerships must encompass not only REE producing countries but also with domestic and foreign users. The U.S. must develop partnerships with other REE producing countries to ensure that any REE we do not produce enough of as a nation, we can obtain from a trading partner.[56] The U.S. may have a large REE reserve but may still have to rely on imports to satisfy specific REE requirements. Japan, who has no internal REE reserves and a high REE demand has been monitors the REE industry and develops strategies to its own needs. Japan has worked with internal industries and is diversifying suppliers along with making foreign investments in Australia and Vietnam. Japan's efforts can an example for the U.S. to follow in developing partnerships as that nation works to develop secure access to REE.

Developing partnerships also should be extended to trading partners and allies that have little to no REE reserves or are net REE importers. The European manufacturing base requires significant amounts of REE. The European and U.S. economies are linked and it is in the U.S. best interest to ensure that Europe can maintain access to REE at an affordable price. Additionally, it is in the interest of the U.S. to ensure access to REE for nations involved in mutual defense treaties with the U.S. as many of our shared modern defense systems require REE to manufacture and operate. Although Russia has begun development of REE production and may have more REE deposits than China[57], Europe may not be able to count on Russia to be a reliable supplier as Russia has used other resources (Natural Gas) as leverage against

her EU neighbors. Partnerships may also be prudent with China as her demand is increasing and may result in China eventually becoming a net REE importing country.

Developing an effective supply chain management policy within not only the DOD but for the whole of the U.S. Federal Government will also help us to understand REE requirements and sources. Emily Coppel, writing for the American Security Project, explained:

> Even commercial uses of rare earth metals, such as cell phones and laptops, have military applications and are critical to operating current military platforms. Yet top U.S. defense officials are unaware of just how dependent they are on rare earths. According to a U.S. National Defense Stockpile report, "[U.S.] defense leaders do not necessarily know exactly which minerals they use in which systems in what amounts, [and] where the minerals came from". Likewise, the U.S. does not track rare earth metals in its weapons systems or platforms. A shortage of rare earths will affect the strength and readiness of the U.S. military until current systems are no longer in operation.[58]

Congress has become involved in correcting DOD supply chain weaknesses and pressuring the DoD to evaluate and mitigate shortcomings. The 2011 National Defense Authorization Act (NDAA) required the Secretary of Defense to assess the supply and demand for rare earth materials in defense applications and identify if any were critical to the production, sustainment, or operation of significant United States military equipment and was subject to interruption of supply, based on actions or events outside the control of the Government of the United States.[59] Prior to the 2011 NDAA, the 2010 NDAA tasked the Comptroller General to submit to the Committees on Armed Services of the Senate and the House of Representatives a report on the usage of rare earth materials in the supply chain of the Department of Defense (DoD).[60] Additionally, the 111th and 112th Congresses have introduced and reviewed in committee multiple bills to

address various areas of the REE supply chain from establishment of new mines to responsible recycling of electronics.

The 2012 NDAA includes a provision for the DOD, using the DLA, to submit a plan to establish an REE inventory to ensure long-term availability; however, this provision leaves the decision to execute the DLA plan to the discretion of the Secretary of Defense. The ambiguity of the REE provision leaves questions as to whether or not Congress will actually provide funding to establish a stockpile or the soundness of DLA's plan to establish an inventory that the Secretary of Defense must decide to establish.[61]

From a national security resource management perspective, it is important to understand the supply chain and requirements for REE. The Defense Production Act (DPA) allows the President to prioritize assets and materials for national security purposes. However, unless the required materials are identified before a crisis, planning cannot be adequately conducted for use of the DPA to support vital industries. The Berry Amendment, passed to protect the U.S. industrial base during periods of adversity and war, restricts DOD from acquiring specialty metals from non-domestic sources. However, in accordance with defense acquisition regulations, the secretaries of the military departments have authority to approve domestically non-available items containing specialty metals for their respective requirements.[62] The DOD underestimated the importance of maintaining a U.S. source of REE when approving weapon systems using lower cost Chinese produced REE. Additionally, the USG is reliant on commercially procured items and has no visibility of REE requirements within Commercial-Off-The-Shelf (COTS) items that have become critical to the operations of the USG. The Berry Amendment restrictions do not apply to the acquisition of COTS

items unless the government requests a modification to the COTS item or the item is offered to the Government with an option that is not normally offered in the commercial marketplace.[63] Even with non-COTS items, the cost and administrative burden to track specialty metals and REE are prohibitive because of the complexity of tracking the multiple tiers of global subcontractors using specialty metals and REE.[64]

Besides national defense, clean and renewable energy uses of REE would benefit from improved supply chain management. David Sandalow, the Assistant Secretary of Energy for Policy and International Affairs stated to Congress, "First, we must globalize supply chains for these materials. To manage supply risk, we need multiple, distributed sources of clean energy materials in the years ahead. This means taking steps to facilitate extraction, refining and manufacturing here in the United States, as well as encouraging our trading partners to expedite the environmentally-sound creation of alternative supplies."[65]

Stockpiling REE is a means of enhancing supply chain management, but cannot be considered as a solution unto itself. A stockpile will decouple REE from variances in supply and demand by acting as a buffer to ensure that REE is available during a crisis or released to control prices when commodity prices rise, stabilizing prices in the market place. Stockpiling comes at a price though, consuming capital to establish an inventory in addition to incurring holding costs to store, maintain, manage, and secure, along with interest costs associated with any financing of inventory. [66]

Stockpiling REE is common in other countries to include Japan, Korea, and even China. In the U.S., Molycorp still has limited mined reserves of REE from past mining operations. Many of the supply for the last few years have come from these above

ground stocks as mining is not keeping up with demand, but these stocks are beginning to run low.[67] This also demonstrates the problem that comes from limited supply availability to create a stockpile. The cost to establish the stockpile may be higher than practicable as stockpile establishment is in competition with demand for production. The cost though can be shared with U.S. industry using shared stockpiles. Shared stockpiles would give access to industry and at the same time provide the USG the ability to direct supplies during crisis.

Ultimately, the USG needs to establish REE within the National Defense Stockpile (NDS). The NDS, managed by the Defense Logistics Agency (DLA) does not include any REE; DLA sold off the few REE included in the NDS in 1998 as they were not considered "critical" at the time.[68] DLA recognizes the inadequacies of the NDS and in the 2009 Reconfiguration of the NDS Report to Congress directly acknowledges the shortfall of multiple REE types within the NDS. [69] However, in the 2010 Strategic Materials Security Program (SMSP) Implementation Plan Report to Congress, DLA did not address REE or a reassessment of the DOD REE supply chain. [70]

Reducing demand for REE is another approach to curb the appetite for REE. This approach includes both development and refinement of current uses of products using REE and development of substitutes for REE for current and future technologies. An example is the replacement of NiMH batteries in hybrid and electric vehicles with lithium-ion batteries that do not use REE.[71] China over the last 20 years has devoted heavy investment into REE research, development, and education. This investment has provided China the intellectual lead in the development of REE and potential substitutes.[72] The U.S. must make necessary and prudent investments to reverse this

trend. The DoE through the Advanced Research Projects Agency–Energy (ARPA-E) has recently sponsored the Rare Earth Alternatives in Critical Technologies (REACT) program.[73] ARPA-E seeks to fund early-stage technology alternatives that reduce or eliminate the dependence on rare earth materials by developing substitutes in two key areas: electric vehicle motors and wind generators. [74]

<u>Conclusion</u>

World REE reserves are sufficient to meet forecasted world consumption well into the 21st century.[75] Unfortunately, the world has been focusing on exploitation of those resources from only one country - China. China's REE supply may only last another 20 years at the current rate of demand. Although China dominates REE supply and has demonstrated the ability to manipulate the REE market to meet Chinese political and economic objectives, China is dependent on the rest of the World to sustain Chinese economic development. China must balance REE exports with internal REE demands. Regardless, global demand for REE will continue to increase in response to defense and commercial requirements for conventional and hybrid automobiles, computers, electronics, and portable equipment.[76]

To counter Chinese dominance in the REE market, maintain a strong economy, achieve clean and renewable energy infrastructure development, and maintain a ready, modernized defense sector the U.S. must develop an REE strategy that ensures long-term access to REE sources.. To accomplish this, the global REE supply chain must be diversified to include the development of domestic and reliable external REE resources. Demand for newly extracted REE must also be reduced through more efficient usage of REE and development of substitute materials. World demand for REE can also be reduced through the development of improved REE production. Finally, improved

policies to make recycling economically viable coupled with investment to improve recycling and reuse technology is required to shift REE market dominance away from China.

The USG and private industry have recently become aware of the danger of China's REE supply dominance and have begun to respond. Congress must follow through with legislation to increase investment and provide management of critical REE resources. The U.S. must develop solutions internally and with reliable trading partners to ensure availability of the volume and assortment of REE required for domestic and international demand. Ultimately, the U.S. must become a net REE exporter, collaborating with other countries to provide the REE that we cannot produce ourselves. Additionally, the U.S. must learn from the past and begin securing other critical materials such as cadmium, tellurium, and helium, which will be required to maintain energy, economic, and defense material independence in the future.[77]

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